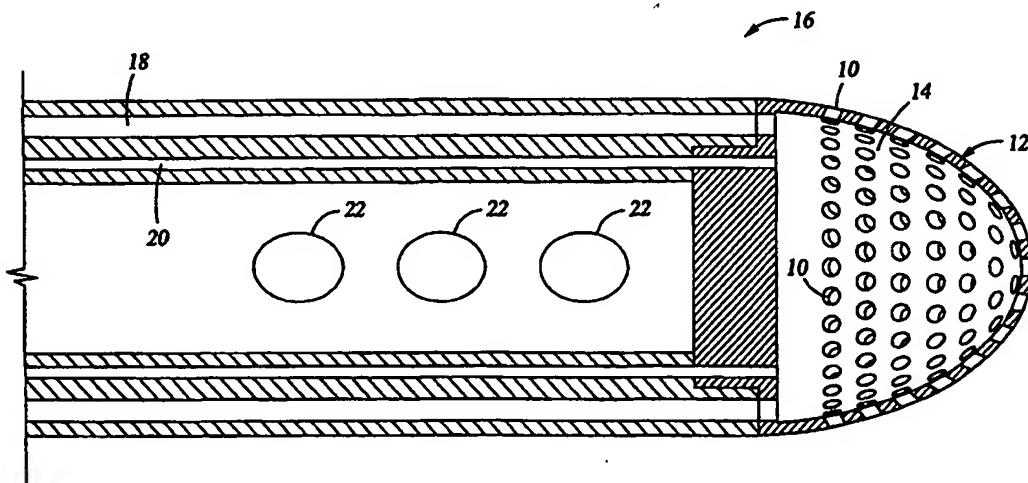




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## (54) Title: LASER-ASSISTED LIPOSUCTION METHOD AND APPARATUS



## (57) Abstract

The present invention is a liposuction cannula having a water source, a laser source, and a suction source. Water is released into an active area (14) within the cannula, and laser energy is directed onto the water molecules (WM) within the active area (14) to energize the water molecules (WM). The energized water molecules (WM) escape from the active area (14) into the surrounding fatty tissue (FT) to break down the fatty tissue (FT), and release liquid fatty material that is removed by aspiration via the cannula.

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## TITLE OF THE INVENTION

## Laser-Assisted Liposuction Method and Apparatus

## BACKGROUND OF THE INVENTION

5       Field of the Invention - This invention is in the field of liposuction surgery, a plastic cosmetic procedure in which fat cells are removed permanently from the body.

Background Information - Conventional liposuction, which features suction as the only active modality for removing unwanted fat cells, is a procedure fraught with complications, including excessive postoperative pain and the potential for major 10 hemorrhagic complications. Several deaths have been reported because of the crudity of conventional liposuction. The mechanism in conventional liposuction is that suction tears the fat cells from their attachments. Unfortunately, suction also tears nerves and blood vessels.

15       Early attempts to use the laser as the operational modality for liposuction surgery met with failure, as the laser was too powerful an energy source. Heat from the laser, which was applied directly to the fat, would, in fact, melt and liquify fatty tissues, but, at the same time, this strong energy source would also damage nerves and blood vessels. In other words, the laser as employed for liposuction in the late 1980s had, in essence, a quite similar complication rate to that of conventional suction-only 20 liposuction. Laser liposuction fell into disfavor and was abandoned as a failure.

25       An advance in the use of lasers for medical procedures occurred during experimentation with "laser phacolysis", a method for removing cataracts through a very small incision. It was noted that, although heat was produced by the laser, the tip of the phacolysis cataract instrument remained essentially cool. The proposed mechanism of action of the laser used there was that the laser light was focused on a metal target inside the tip. Optical breakdown occurs, leading to a shock wave. It is this shockwave which causes disruption of the cataract. In other words, the laser works indirectly as a facilitator, allowing the shockwave resulting from optical breakdown to do the actual work of breaking the quite-hard cataract into small pieces, 30 which can then be aspirated.

## BRIEF SUMMARY OF THE INVENTION

In the present invention, laser energy is emitted into an "active area" located within the distal end of the cannula. Simultaneously, one or more jetstreams of water are emitted into this same active area.

5        The laser bombards the water molecules supplied by the jetstream, and, secondary to this laser energy bombardment and the subsequent impartation of laser energy from the laser to the water molecules, the water molecules become extremely agitated. These "hyperkinetized" water molecules escape from the active area within the distal cannula tip through holes or ports into the substrate fatty tissue. The  
10      violently moving water molecules disrupt the adipocyte cell walls, releasing the liquidous material within the cells. This liquified fat is then aspirated by the cannula through one or more suction ports of the cannula, which is attached proximally to an outflow tube connected to a suction pump apparatus. The aspiration suction ports are preferably located on the lateral aspect of the cannula proximal to the active area, but,  
15      alternatively, a suction port can also be employed at the extreme distal end of the cannula via a tube traversing the active area and connecting to the internal hollow aspect of the cannula proximal to the active area.

20      The process may be observed via an endoscope attached separately to the external surface wall of the cannula. This feature is primarily useful for eyelid, face, and neck procedures.

The novel features of this invention, as well as the invention itself, will be best understood from the attached drawings, taken along with the following description, in which similar reference characters refer to similar parts, and in which:

25

## BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

Figure 1 is a section view of one embodiment of the present invention, showing a walled enclosure around the active area and lateral suction ports;

30      Figure 2 is a schematic view of the interaction of the present invention with surrounding fatty tissues;

Figure 3 is a section view of a second embodiment of the present invention, showing a scaffold type enclosure around the active area and lateral suction ports;

Figures 4A, 4B, and 4C are schematics showing three different embodiments of the openings in the walled enclosure around the active area;

Figure 5 is a partial section of the rigid enclosure, showing the rounded edges which can be used on the openings in the enclosure around the active area;

5 Figure 6 is a transverse section of the cannula, showing one arrangement of the water channels and optical fibers;

Figure 7 is a schematic view of the different angles at which the water may be directed into the active area; and

10 Figure 8 is a section of a third embodiment of the present invention, showing a distal suction port and lateral suction ports.

#### DETAILED DESCRIPTION OF THE INVENTION

There are two mechanisms of action which may be brought into play in the present invention as follows:

15 (A) a "water-blasting" mechanical effect of the water molecules against the adipocyte walls, similar to "sandblasting", but using highly energized water molecules instead of sand; or,

(B) a transfer of heat from the highly-energized water molecules to the adipocyte cells walls, or a combination of both (A) and (B).

20 The intense heat transferred by the laser and absorbed by the water molecules is very transient in duration, however. This is related, it is believed, to the very small mass of the individual water molecules, such that a significant temperature rise in the substrate fatty tissues does not occur. Thus, the burning noted with prior attempts to perform laser liposuction surgery is absent with the presently-disclosed invention. In 25 other words, an intense heat source -- the laser -- is essentially "cool" in the present invention, in that temperature elevation does not occur to any significant degree in the fatty tissues. It must be kept in mind that in the present invention, application of the laser energy to the fatty tissues is indirect, in that it is not the laser which is performing the surgery, but rather the highly-energized water molecules.

30 It is commonly recognized that cell death occurs when tissues are heated for any length of time beyond 43 degrees C. Because temperature elevation within the

substrate fatty tissue is kept below 43 degrees, damage to nerves and blood vessels during practice of the present invention is minimized.

The present invention operates differently from other medical "cool lasers", such as dental lasers, in that the jet-stream of water is directed into an active area 5 within the cannula, rather than being directed externally from the cannula into, or onto, the surrounding tissue, such as with dental procedures or skin resurfacing procedures.

In one embodiment, shown in Figure 1, a plurality of ports, openings, or holes 10 are formed in a substantially rigid walled enclosure 12 around the "active area" 14 10 of the cannula 16, allowing the highly-energized water molecules to leave the active area 14 within the cannula 16, thus reaching the substrate fatty tissue. One or more water channels 18 conduct water to the active area 14, and one or more optical fibers 20 conduct laser energy to the active area 14. One or more lateral suction ports 22 can be provided in the wall of the cannula 16, for aspirating liquid fatty material. Figure 8 15 illustrates that a suction port 32 can also be employed at the extreme distal end of the cannula 16 via a tube traversing the active area 14 and connecting to the internal hollow aspect of the cannula 16 proximal to the active area 14.

Figure 2 illustrates how the energized water molecules WM exit the active area 14 via the ports 10 in the walled enclosure 12, to break down the fatty tissue FT 20 and liquefy the fatty material.

In another embodiment, shown in Figure 3, a ribbed "scaffolding-style" tip 24 on the distal end of the cannula 16, in essence, is another embodiment of the substantially rigid enclosure which creates an "intracannular" space which constitutes the enclosed active area 14, which is separated physically from the fatty tissue itself by 25 the scaffolding ribs 26, as they glide through the fatty tissue. The energized water molecules exit jets in the cannula 16 between the scaffolding ribs 26 in this embodiment. Both embodiments, that is, the ported embodiment and the ribbed embodiment have practical applications.

The preferred embodiment, in either case, has a "bullet-shaped" distal tip 12, 30 24, as this reduces the friction required to part and to separate the fatty tissue as the cannula 16 glides through the tissue in a back and forth fashion. A little side movement is permitted on each forward thrust, as the surgeon finds a new area to

treat. Surgeon fatigue is kept to a minimum with such a bullet-shaped distal tip. In addition, less tissue trauma is attendant with the use of a bullet-tip. The bullet shaped tip can be employed either in the ported embodiment or the scaffolding embodiment. A flatter tip, although not the preferred embodiment, is not intended to be excluded 5 from this invention, however.

The laser optical fibers 20 and the water jetstream channels 18 course through the outer walls of the hollow cannula 16 to the proximal aspect of the active area 14, thus allowing laser emissions and water jetstream discharge into the active area 14. A plurality of such laser fibers 20 and water jetstream channels 18 is envisioned in the 10 preferred embodiment. However, for extremely delicate operations, such as to remove fatty tissue from the lower eyelids, a single jetstream and a single laser optical fiber can be utilized. These laser fibers 20 and water channels 18 can be directed at different angles into the active area 14, as shown in Figure 7, so that the water molecules can be hyperkinetized in a specific part of the active area 14, or 15 throughout, the active area 14.

In the ported embodiment, the ports 10 in the distal tip enclosure 12 can be very small, such as 0.25 mm. in diameter, or quite large, such as 2.5 to 3.0 mm. in diameter, or even larger, as illustrated in Figures 4A and 4B. Further, the ports 10 can be positioned throughout the enclosure wall 12, or limited to the lateral aspect thereof, 20 as in Figure 4C.

The edges 30 of the ports 10, and the edges of the scaffolding ribs 26, should be specially treated to be rounded and smoothed, as shown in Figure 5, since any sharp edge of the hole tends to function in a knife-like fashion, which is undesirable. In addition, the walls of the cannula 16 immediately adjacent to the port 10 can be 25 built up circumferentially to minimize even further any potential cutting action attributable to the ports 10 themselves.

The laser fibers 20 and water jetstream channels 18 may be in a single row, or two, three, or more rows, traversing within the walls of the cannula 16, as shown in Figure 6. The laser fibers 20 or water jetstream channels 18 may also traverse through 30 a longitudinal tube extending up the axis of the cannula 16, or off center but parallel to the axis, if desired. Nevertheless, both the laser energy and at least one water jetstream must be supplied into the active area 14 within the cannula 16, with the laser

beam not exiting the cannula 16, as this allows for the hyperkinetization effect of the laser energy upon the water molecules in a safe, internal environment, namely, the active area 14. Supplying the jetstream and the laser directly into or onto the tissue external to the cannula 16 would be quite dangerous, as the laser would then be in a 5 physical position to operate directly upon the substrate fatty tissue. The purpose of the present invention is to prevent any possibility of the direct action of the laser on the surrounding tissue.

The cool lasers presently used in oral or dental treatments, and in skin resurfacing, would not be suitable for the removal of fatty tissue. As opposed to a 10 very hard tissue, such as dental tissue, or a soft, but yet relatively firm tissue, such as skin, fatty tissue is composed of uniquely fragile fat cells. In fact, fat cells are among the most fragile cells in the entire body.

The present invention allows for preferentially treating fat cells, while sparing 15 nearby blood vessels and nerve cells. In this invention, the very fragile fat cell walls are disrupted, thus releasing liquidous fatty material to be aspirated, while the blood vessel walls, which are sturdier in construction than those of fat cells, are generally spared. It is fat cells which are preferentially attacked by the highly energized, 20 hyperkinetized water molecules. For this reason, bleeding from blood vessel damage is minimized. Likewise, nerve damage tends to be minimized, in that the larger pain nerves tend to be more robust than the extremely delicate fat cells.

While the particular invention as herein shown and disclosed in detail is fully capable of obtaining the objects and providing the advantages hereinbefore stated, it is to be understood that this disclosure is merely illustrative of the presently preferred 25 embodiments of the invention and that no limitations are intended other than as described in the appended claims.

## CLAIMS

I claim:

1. An apparatus for removal of fatty tissue, comprising:
  2. a hollow cannula;
  3. a substantially rigid enclosure on said cannula, said enclosure being shaped to  
4. enclose an active area within said cannula, and protect said active area  
5. from intrusion by surrounding tissues;
  6. a water source on said cannula, said water source being disposed to release  
7. water into said active area enclosed within said cannula;
  8. a laser source on said cannula, said laser source being disposed to impinge  
9. laser energy on said water from said water source in said active area  
10. enclosed within said cannula, to energize said water molecules, said  
11. laser source being arranged relative to said water source and said  
12. enclosure so as to prevent escape of any laser energy from said  
13. enclosure prior to impingement of said laser energy upon said water  
14. molecules;
  15. an opening in said enclosure, said opening being positioned to allow said  
16. energized water molecules to escape from said enclosure to contact and  
17. break down surrounding fatty tissues; and
  18. a suction port on said cannula for aspirating liquid material resulting from  
19. breakdown of surrounding fatty tissues.
1. 2. An apparatus for removal of fatty tissue, as recited in claim 1, wherein  
2. said enclosure comprises a portion of a wall of said cannula, with said active area  
3. being enclosed within said portion of said wall.

1           3. An apparatus for removal of fatty tissue, as recited in claim 1, wherein  
2    said enclosure comprises a plurality of substantially rigid ribs attached to said cannula,  
3    with said active area being substantially surrounded by said ribs.

1           4. An apparatus for removal of fatty tissue, as recited in claim 1, wherein  
2    said water source comprises at least one water jet positioned to spray water molecules  
3    into said active area.

1           5. An apparatus for removal of fatty tissue, as recited in claim 1, wherein  
2    said laser source comprises at least one optical fiber positioned to direct at least one  
3    laser beam on said water within said active area.

1           6. A method for removal of fatty tissue, said method comprising:  
2           providing a hollow cannula having a substantially rigid enclosure, a water  
3           source, a laser source, and a suction port;  
4           releasing water molecules from said water source into an active area enclosed  
5           within said rigid enclosure within said cannula;  
6           impinging laser energy from said laser source onto said water molecules from  
7           said water source in said active area enclosed within said cannula, to  
8           energize said water molecules, without allowing escape of any laser  
9           energy from said enclosure prior to impingement of said laser energy  
10           upon said water molecules;  
11           allowing said energized water molecules to escape through openings in said  
12           enclosure to contact and break down surrounding fatty tissues; and  
13           aspirating liquid material resulting from breakdown of surrounding fatty  
14           tissues, via said suction port.

1           7.     A method for removal of fatty tissue, as recited in claim 6, said method  
2     further comprising releasing said water molecules from a plurality of said said water  
3     sources into said active area.

1           8.     A method for removal of fatty tissue, as recited in claim 6, said method  
2     further comprising impinging said laser energy from a plurality of said laser sources  
3     onto said water molecules in said active area.

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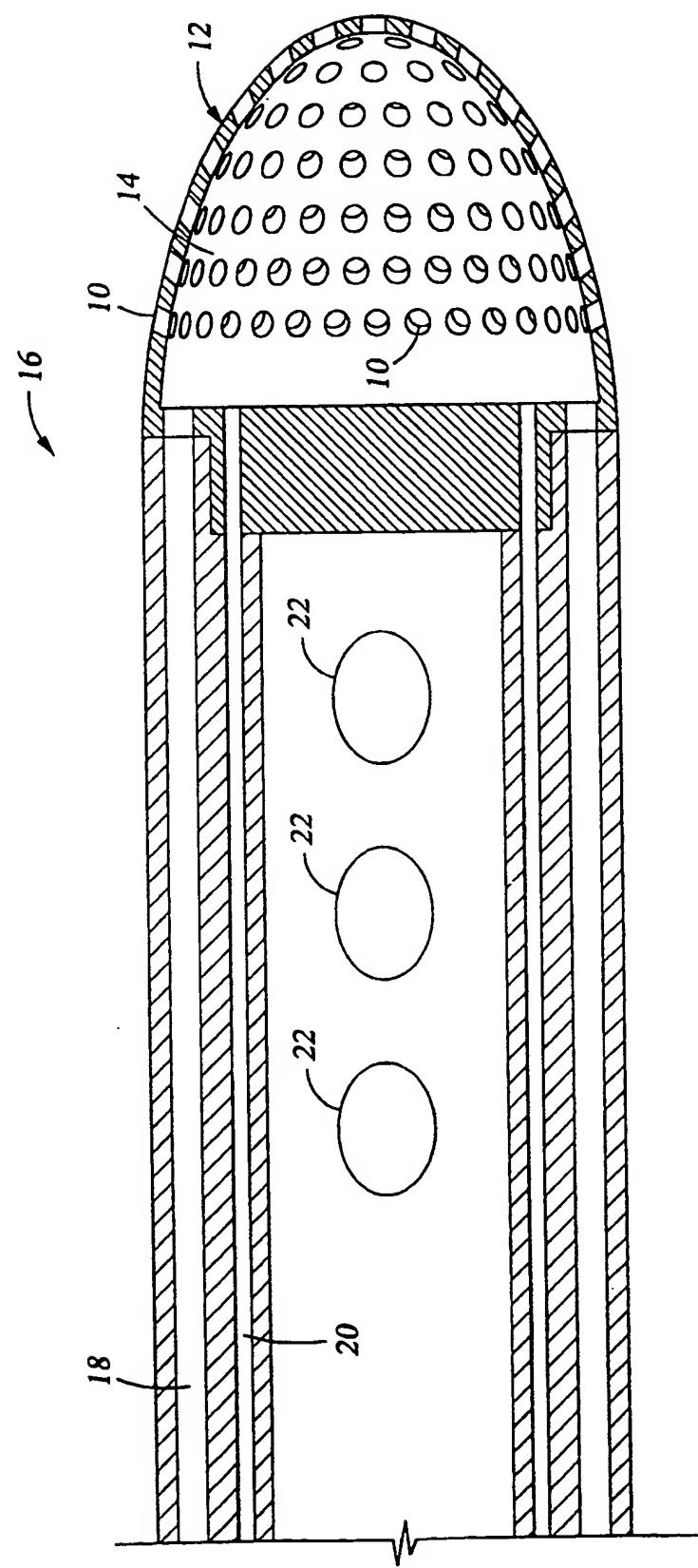


Fig. 1

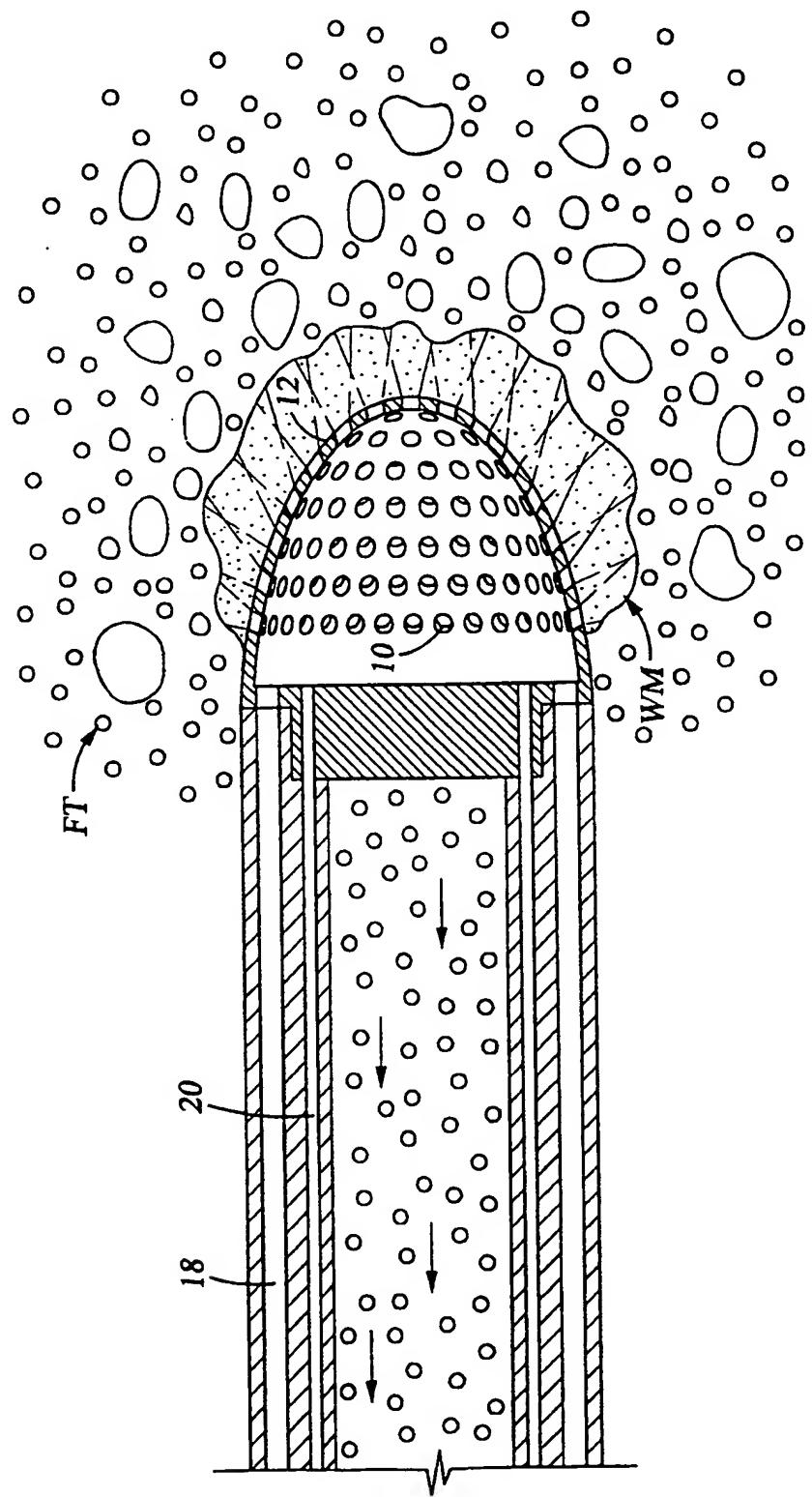


Fig. 2

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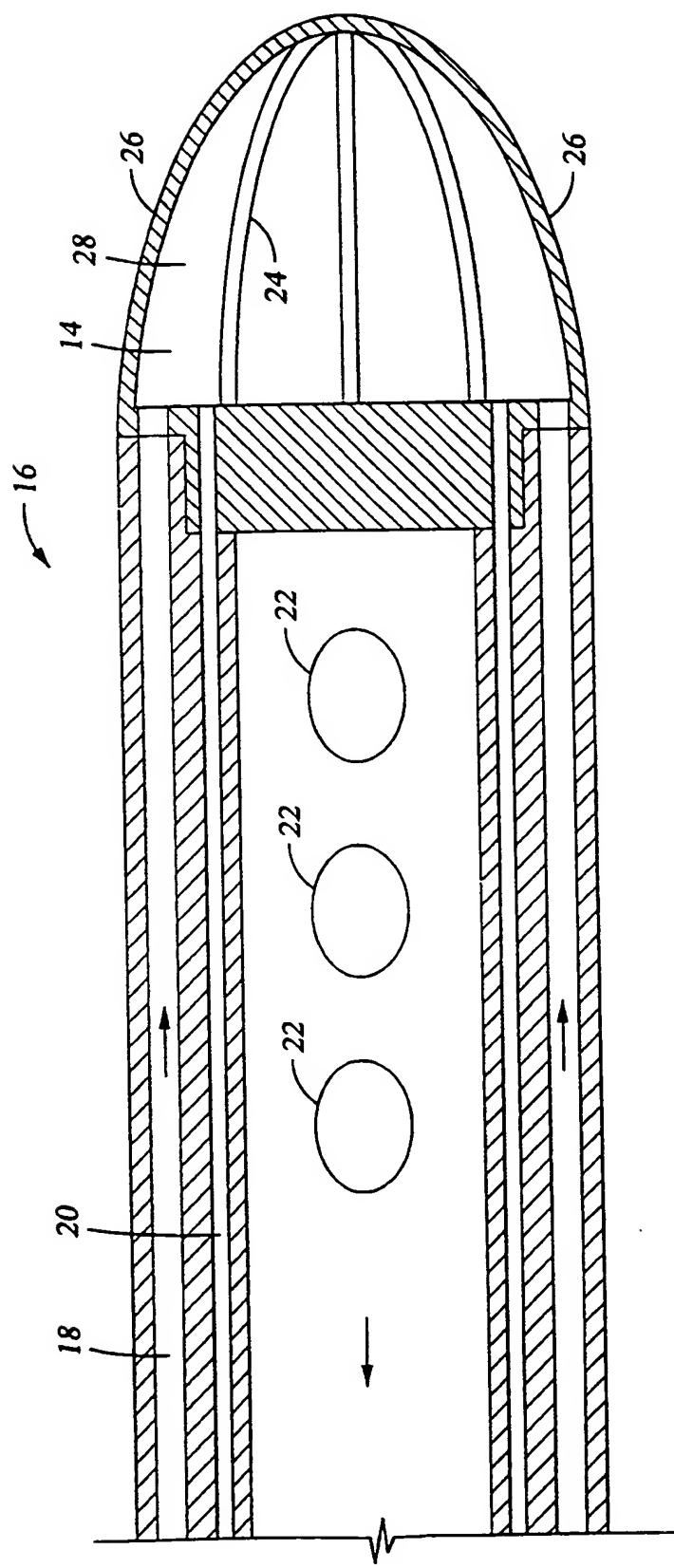


Fig. 3

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Fig. 4A

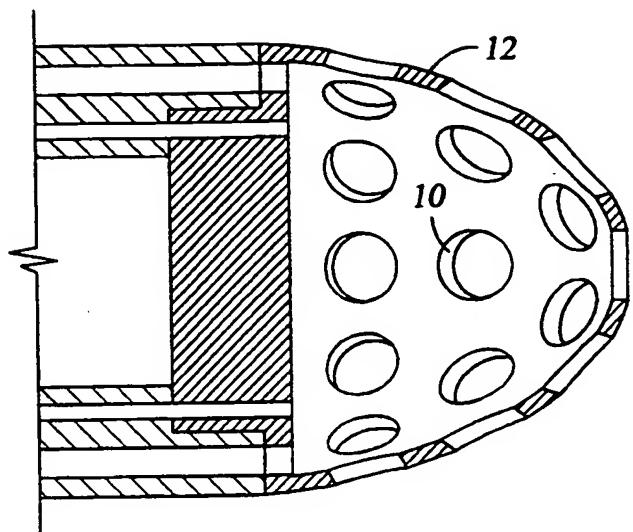


Fig. 4B

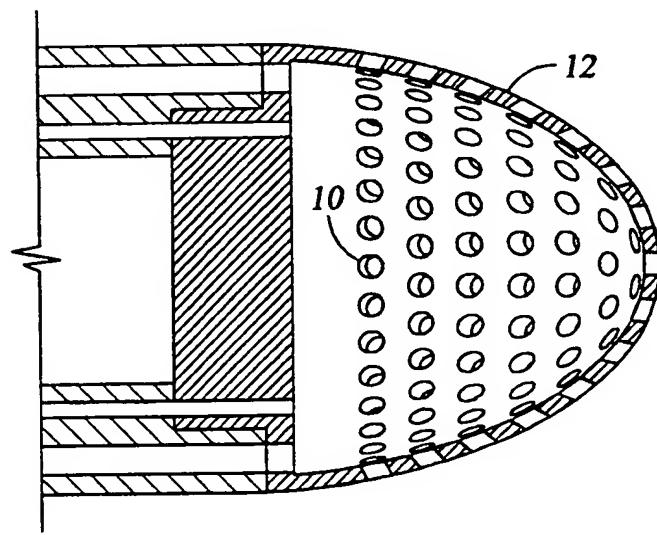
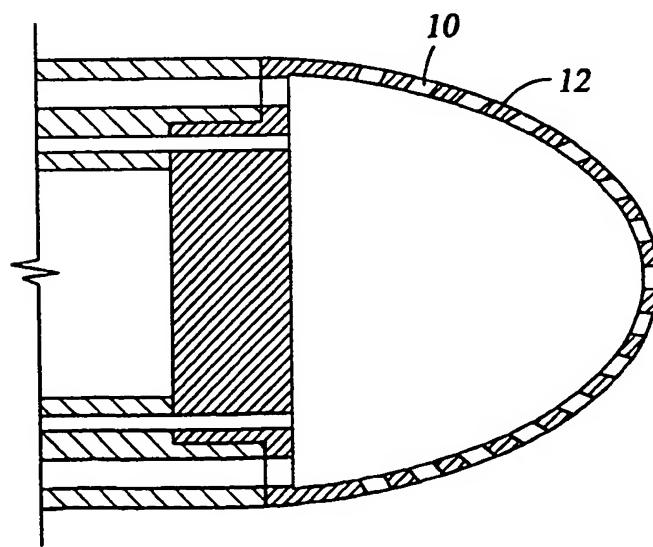


Fig. 4C



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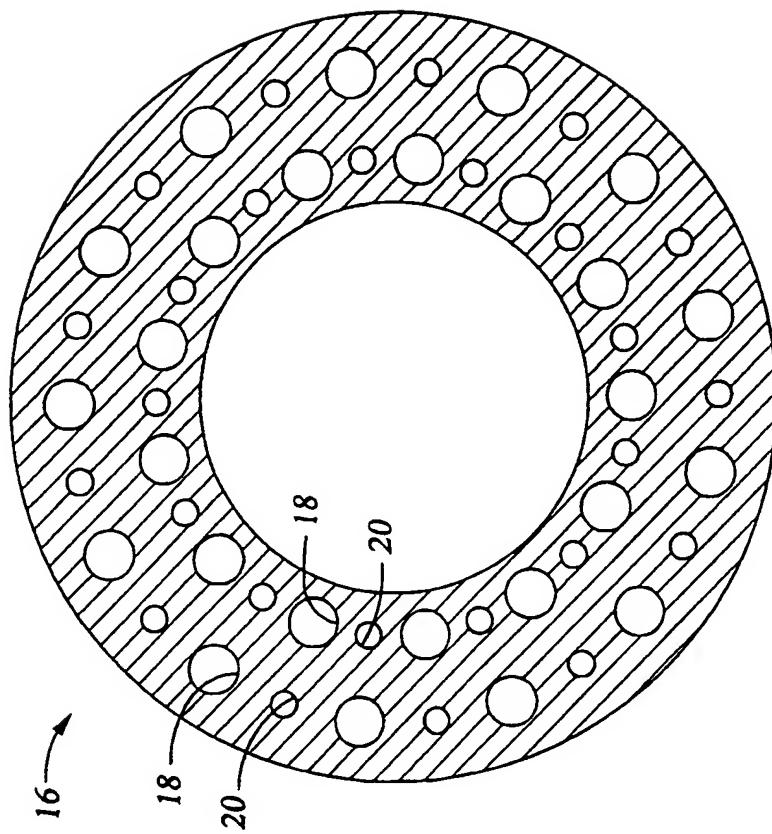


Fig. 6

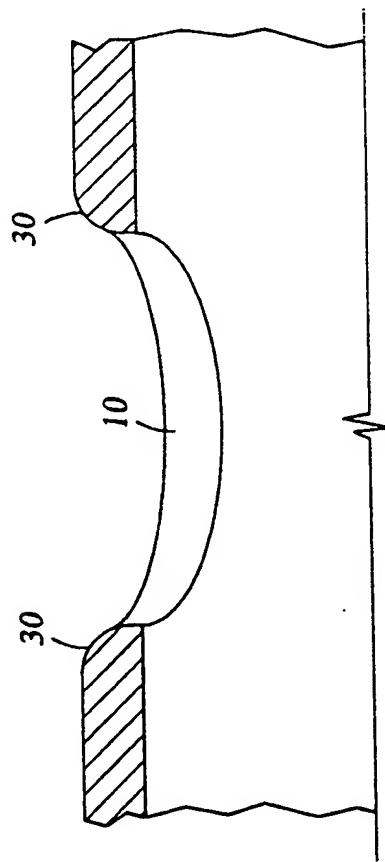


Fig. 5

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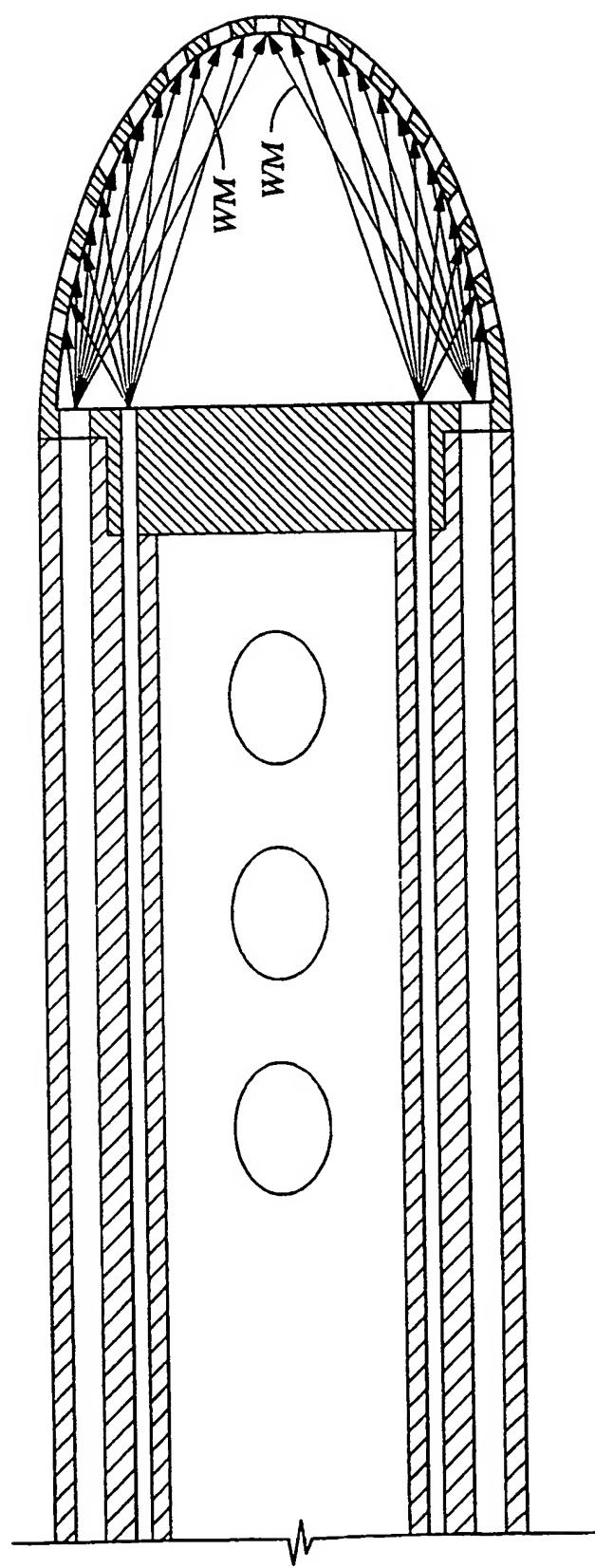


Fig. 7

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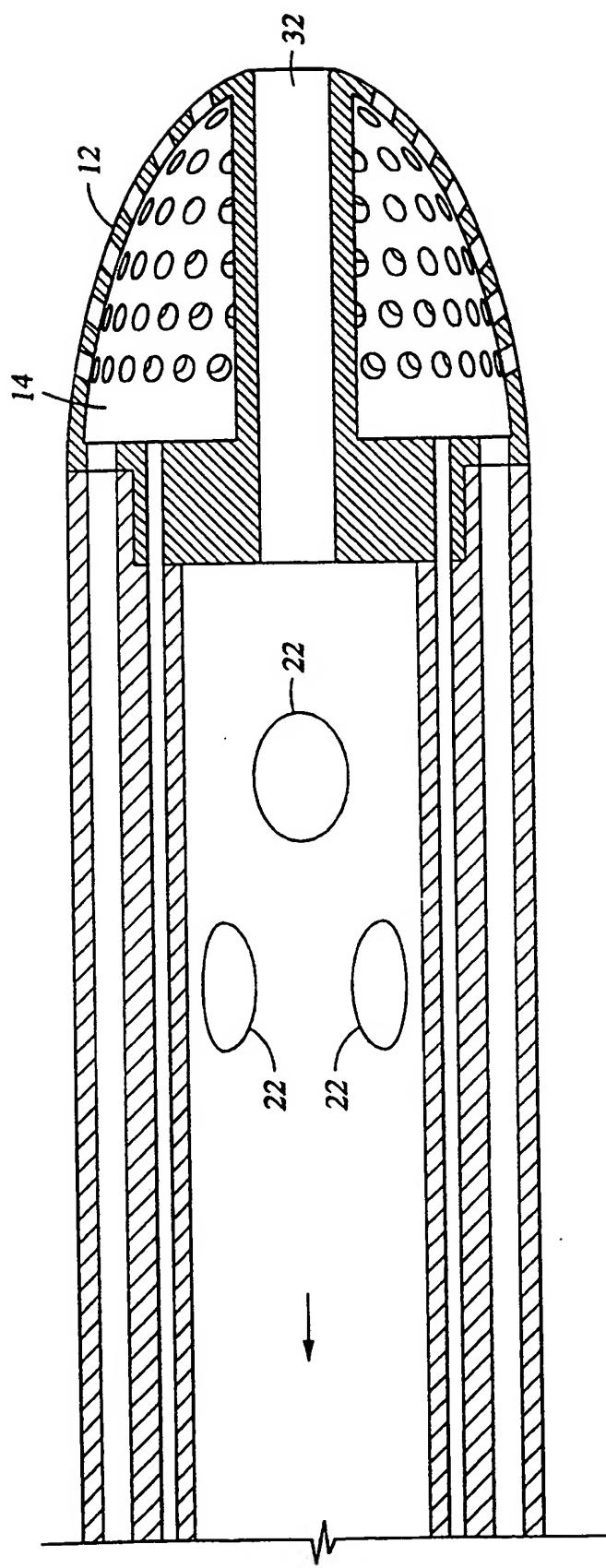


Fig. 8

## INTERNATIONAL SEARCH REPORT

International application No.

PCT/US98/22977

## A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) : A61B 17/36  
US CL : 606/13

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 606/2, 2.5, 9, 13-16, 167; 607/88, 89, 92

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A,P	US 5,766,194 A (SMITH) 16 June 1998, entire document.	1, 2, 6
A	US 5,312,399 A (HAKKY et al.) 17 May 1994, entire document.	1, 2, 5
A	US 5,129,896 A (HASSEON) 14 July 1992, entire document.	1, 2, 5

 Further documents are listed in the continuation of Box C.  See patent family annex.

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Date of the actual completion of the international search

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